

**TB9100** base station  
**P25 CG** console gateway

# Calibration Software User's Manual



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# Contents

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<b>Preface</b> .....	<b>iii</b>
Typographical Conventions .....	iii
Associated Documentation .....	iii
Publication Record .....	iv
<b>Basic Tasks</b> .....	<b>1</b>
Using the TB9100 Calibration Software .....	1
About the Toolbar .....	2
About the Status Bar .....	2
Equipment Required .....	3
Calibration Overview .....	3
Field Calibration .....	4
Service Center Calibration .....	4
P25 Console Gateway Calibration .....	5
Selecting the Communications Port .....	5
Setting Up the Equipment .....	6
Connecting the Calibration Software .....	7
Disconnecting from the Base Station/Reciter .....	7
Troubleshooting .....	7
<b>Adjusting the Frequency Setup</b> .....	<b>8</b>
Adjusting the Receiver Lock Band .....	8
Tuning a UHF Receiver Front End .....	9
Tuning a VHF Receiver Front End .....	11
Adjusting the Exciter Lock Band .....	13
Selecting the Exciter Sub-band .....	14
<b>Calibrating the Reciter</b> .....	<b>15</b>
Calibrating the Exciter .....	15
Automatically Tune the Frequency Control Loop (FCL) .....	15
Calibrating the FCL .....	15
Calibrating the VCO .....	17
Calibrating the RSSI .....	18
Calibrating the Balanced Line .....	20
Calibrating the Unbalanced Lines .....	21
Carrier Frequency Offset Adjustment .....	21
<b>Calibrating the Power Amplifier</b> .....	<b>25</b>
Calibrating the PA Bias .....	25
Calibrating the Forward and Reverse Detector Bias Voltages .....	26
Calibrating the PA Power .....	26
Troubleshooting Tips .....	28
<b>Calibrating the Power Management Unit</b> .....	<b>29</b>

Calibrating the PMU Output Voltage .....	29
<b>Index .....</b>	<b>31</b>

# Preface

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Welcome to the TB9100 Calibration Software User's Manual. This manual provides you with information about the Tait TB9100 Calibration Software in PDF format. You can view it online or print it if you want a paper copy. It describes how to use Version 03.06 of the Calibration Software.

## Typographical Conventions

'File > Exit' means 'click File on the menu bar, then select Exit'.

## Associated Documentation

- *Online Help.* The Calibration Software also has online Help. It contains more or less the same information as this manual. To view it, start the Calibration Software, then press F1 or click the Help icon on the toolbar. If you are in a dialog box, click the Help button.
- *TBA0STU/TBA0STP CTU Operation Manual.* This manual (MBA-00013-xx) provides detailed information about the Calibration and Test Unit.
- *TB9100 Installation and Operation Manual (MBA-00002-xx).*
- *TB8100 Service Manual (service centers only).* A glossary of terms is available in this manual (MBA-00016-xx).
- *TB9100 Reciter Service Manual (service centers only).*

For additional documentation, see the prefaces of the TB9100 Installation and Operation Manual and the TB9100 Customer Service Software User's Manual or the CSS online Help.

Technical notes are published from time to time to describe applications for Tait products, to provide technical details not included in manuals, and to offer solutions for any problems that arise. Look for them on Tait's technical support website.

## Publication Record

Issue	Date	Description
MBA-00004-01	January 2005	First release of the this manual. It describes Version 02.03 of the Tait TB9100 Calibration Software.
MBA-00004-02	March 2005	First full release of the this manual. It describes Version 02.05 of the Tait TB9100 Calibration Software and Version 01.10 of the TB9100 base station.
MBA-00004-03	August 2005	Minor updates. The manual describes Version 02.07 of the Tait TB9100 Calibration Software and Version 1.2 of the TB9100 base station. Front end tuning is explained separately for UHF and VHF receivers.
MBA-00004-04	May 2006	Describes Version 03.00 of the Tait TB9100 Calibration Software and Version 2.1x of the TB9100 base station. Calibration for K-band base stations, analog gateways, and receive-only base stations. Murata tuning tool now not used for UHF (H-band and K-band) receiver front end, as a different helical filter is fitted.
MBA-00004-05	February 2007	Describes Version 03.06 of the Tait TB9100 Calibration Software and Version 3.0x of the TB9100 base station. The FCL and VCO calibration wizards have been improved.

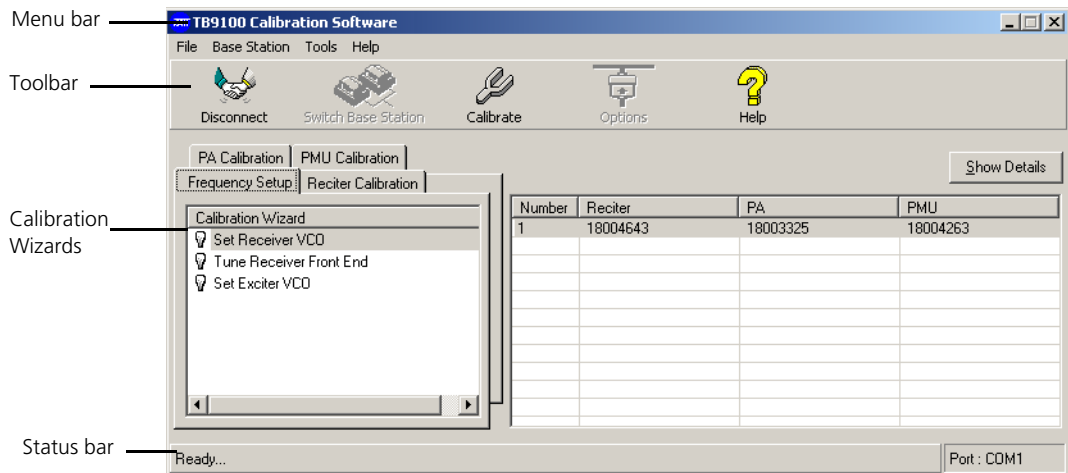
# Basic Tasks

The TB9100 Calibration Software is a Windows-based software program that allows you to adjust the switching ranges of Tait TB9100 base stations (both receiver and transmitter), and to flatten the receiver response across that switching range.

The Calibration Software is also used to calibrate the reciter, the PA, and the PMU after servicing.

## Using the TB9100 Calibration Software

When you start the Calibration Software, the main program window appears.



The main program window has four tabs. The Calibration Wizards displayed on each tab are only visible once you are connected to the reciter or the base station.

When the Calibration Software is connected to the reciter or base station, you can view further details (such as module number, type, serial number, band, and hardware version) about the currently selected module by clicking **Show Details**.

- Frequency Setup tab** Shows the Calibration Wizards that take you step-by-step through the frequency setup.
- Reciter Calibration tab** Shows the calibration procedures that you can perform on the reciter. The Calibration Wizard takes you step-by-step through the procedure you have selected.
- PA Calibration tab** Shows the calibration procedures that you can perform on the power amplifier. The Calibration Wizard takes you step-by-step through the procedure you have selected.
- PMU Calibration tab** Shows the procedure that you can perform on the PMU.

## About the Toolbar

The toolbar gives you quick access to commonly used menu commands. For example, instead of selecting Base Station > Calibrate, you can click the Calibrate icon on the toolbar.



Connect	Connects the Calibration Software to the base station and opens the communication channels.
Switch Base Station	Lets you select another base station to calibrate if there are multiple base stations in the rack (not currently supported).
Calibrate	Runs the Calibration Wizard for the currently selected task.
Options	Allows you to set the COM port and default calibration mode.
Help	Opens the online help for the window you are currently in.

## About the Status Bar

The status bar provides you with useful information that supplements the display in the main window.





## Equipment Required

You need the following equipment for field calibration:

- Calibration and Test Unit (CTU, order code TBA0STU), which comes complete with the cables you will need for connection to the reciter/PA and the PC. For more information about the CTU, please refer to the CTU Operation Manual.



- Tool kit (order code TBA0ST2) which comprises tuning tools and the required screwdrivers in a tool pouch. The ceramic-tipped Murata tuning tool is used for most procedures, but the metal-tipped Johanson 8777 tuning tool with its narrower blade is needed for tuning the front end of H-band and K-band receivers.
- 10-30 V DC power supply (if the PMU does not have a 12 V or 24 V auxiliary power supply module)
- RS-232 cable
- RF attenuator (optional – depends on the setup)

You may also need the following additional equipment:

- Frequency counter with an accuracy of 50 parts per billion or better and a current calibration certificate
- Modulation meter (the calibration software supports the Agilent 8920, the Aeroflex IFR2975, and the R & S CMS54)
- RF signal source
- AC millivoltmeter (one with a differential input may be required for [“Calibrating the Balanced Line”](#) on page 20)

Refer to the individual procedures for equipment setup diagrams.

## Calibration Overview

Any calibration process creates digital values and a calibration date, which are stored in the base station. The CSS can display the date of the last calibration. Many calibration procedures initially clear the stored digital values. If you do not complete the procedure or the stored digital values are outside acceptable limits, the module is left uncalibrated. An uncalibrated reciter cannot be put into Run mode. An uncalibrated PA generates a calibration invalid alarm.

If the procedure you are performing requires access to tuning holes, you need to remove the reciter from the subrack and connect to it via the CTU.

The following tables summarize, for each procedure, whether or not you need to remove the reciter from the subrack, and what equipment (in addition to a PC with the Calibration Software) you will need.

## Field Calibration

The following procedures can be carried out in the field.

Procedure	Connection	Equipment Required
Adjusting receiver lock band	Outside subrack	Murata tuning tool
Tuning the receiver	Outside subrack	Murata tuning tool, Johanson tuning tool (for H-band and K-band reciters), CTU
Calibrating the RSSI	Inside subrack	RF signal source
Adjusting exciter lock band	Outside subrack	Murata tuning tool
Calibrating the TCXO (see <a href="#">"Carrier Frequency Offset Adjustment" on page 21</a> )	Outside subrack	Murata tuning tool, Frequency counter, RF attenuator (only if using PA)

In addition, the following procedures should be carried out if the base station fails a modulation fidelity test.

Procedure	Connection	Equipment Required
Automatically tuning FCL	Inside subrack	None
Calibrating the FCL modulation	Outside subrack	Murata tuning tool, modulation meter, RF attenuator (only if using PA)
Calibrating the VCO modulation	Outside subrack	Murata tuning tool, modulation meter, RF attenuator (only if using PA)

## Service Center Calibration

The following procedures may need to be carried out after a module has been serviced. They are in addition to the field procedures listed above.



**Note:** Replacing or repairing a board module may mean that the module's product code, product type (frequency band), serial number, and/or hardware version need to be re-entered or altered.

To do this, your Calibration Software needs a dongle. The Service Manual indicates when a module detail needs re-entering or altering.

### Reciter

Procedure	Connection	Equipment Required
Calibrating the balanced lines (the analog line)	Inside subrack	CTU, AC millivoltmeter (perhaps with differential input)

## Power Amplifier

Procedure	Connection	Equipment Required
Calibrating the PA bias	Inside subrack	None required
Calibrating the forward & reverse detector bias voltages	Inside subrack	None required
Calibrating the PA power	Inside subrack	None required

## Power Management Unit

Procedure	Connection	Equipment Required
Output voltage calibration	Inside subrack	Digital multimeter

## Receive-Only Base Station Calibration

The reciter in a TB9100 receive-only base station differs only in the absence of a Transmit enable feature license. (The TB8100 receive-only reciter is a hardware variant with no transmit capability.) Accordingly, the calibration software reports the reciter type as standard. You need to carry out receiver-related calibration procedures. Procedures related to the exciter can be carried out but serve no purpose.

## P25 Console Gateway Calibration

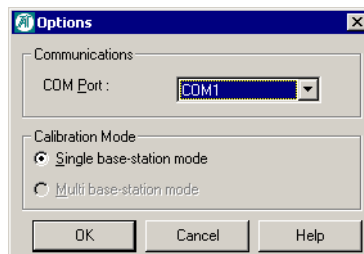
The current P25 Console Gateway is effectively a reciter without feature licenses for transmitting and receiving. Accordingly, the calibration software reports the reciter type as standard. You need to carry out procedures that relate to the analog line. Procedures related to the exciter and receiver can be carried out but serve no purpose.

## Selecting the Communications Port

Before you connect to a base station, you should first define the communications (COM) port that you want to use.

### To select the COM port

1. Select Tools > Options.



2. Select the port that you want to use from the COM Port list.



**Note:** The available COM ports are detected by the program and appear in the list.

3. Click **OK**.

The COM port you selected is now shown on the status bar.

## Setting Up the Equipment

For field calibration procedures, you need to remove the reciter from the subrack to gain access to tuning holes. If a CTU is required for one procedure, it is probably easiest to use it for all your procedures. If it is not required, you can connect the PC directly to the reciter.

### To set up the equipment

1. Remove the reciter from the subrack, following the instructions in the Installation and Operation Manual. (Note that for some service center procedures, the reciter can be left in the subrack.)
2. Connect the reciter and the PC to the CTU according to the diagram below.
  - Connect the reciter's analog RJ-45 socket (labeled AUD) to the CTU's RJ-45 using the RJ45 cable
  - Connect the reciter's 9-way serial connector (labeled DIG) to the CTU's 9-way male connector using the 9-way cable.
  - Connect your PC to the CTU by plugging an RS-232 cable into the 9-way serial port labeled 10101.

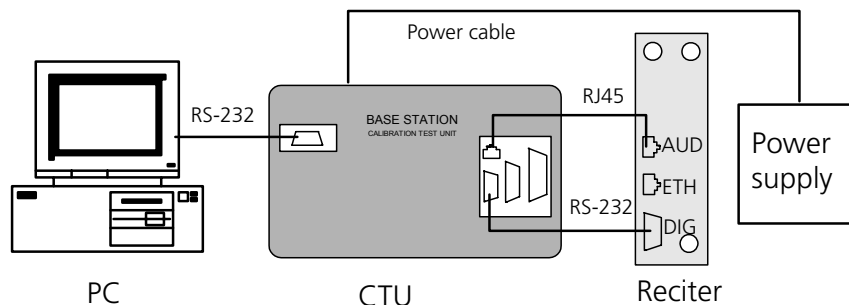
(If you are not connecting via the CTU, connect the PC to DIG using the RS-232 cable. No other connections are required.)



**Note:** Tait recommends that you disable the PC's hardware handshaking. The DIG connector is used for digital I/O as well as for RS-232 and this could interfere with the handshaking.

Alternatively, use a special DB9 cable that has only three connectors (for pins 2, 3, and 5).

3. Connect the CTU to the 10-30V DC power supply using the power cable supplied. If the base station's PMU has a 12 V or 24 V auxiliary power output, you can use this as the power supply. A connector is supplied with the CTU. The reciter must also be supplied with power, but do not power it up yet.

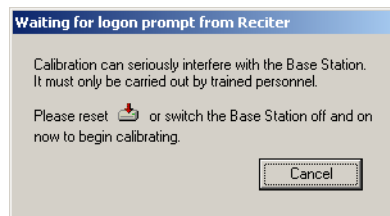


## Connecting the Calibration Software

Before you can begin calibrating, you must establish a connection between the calibration software and the reciter.

### To connect to the reciter

1. Make sure that the equipment is set up but that the reciter is not powered up.
2. Start the Calibration Software program, and check that the **correct COM port is selected**.
3. Click **Connect** to start the connection process.
4. When you see the “Waiting for logon prompt from Reciter” screen, power up the reciter. If it is already on, turn it off, and then on.



5. When the Calibration Software program has successfully connected to the reciter (this can take up to 30 seconds), the Calibration Wizards are displayed in the main window.

You are now ready to tune and calibrate the reciter.

## Disconnecting from the Base Station/Reciter

Once calibration is completed, end the process as follows.

1. Click **Disconnect**.



**Important:** Disconnecting when a calibration process is not completed may leave the base station in an uncalibrated state.

2. Exit the Calibration Software.
3. Turn the base station off and then on again to take it out of calibration mode. The base station is now in Standby mode, ready for configuration.

## Troubleshooting

**Application Errors** All application errors are recorded in a log file called “CCTMCOMMSLog.log”. The data, time, location, and any other useful information is stored in this file, which may be helpful when troubleshooting. The file is saved in the Calibration Software’s application folder.

**Verifying the Software Version** If you need to verify the version of the Calibration Software, select Help > About.

**Commands Record** All the commands sent and received by Calibration Software are saved in a file called “CCTM.log”. The date, time, command number, and parameters are all stored in this file, which may be helpful when troubleshooting. The file is also saved in the Logfiles subfolder and stores up to 1000 of the most recent logged items.

# Adjusting the Frequency Setup

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Before the TB9100 base station is installed, connected, and configured, you must prepare it for operation by adjusting the switching range of the receiver, optimizing the receiver response across the switching range, and adjusting the exciter lock band or selecting an exciter sub-band.



**Note:** If the required switching range for the base station has already been defined, you don't need to perform these procedures.



**Tip:** Use the TB9100 CSS to monitor the base station and find out its current switching range.




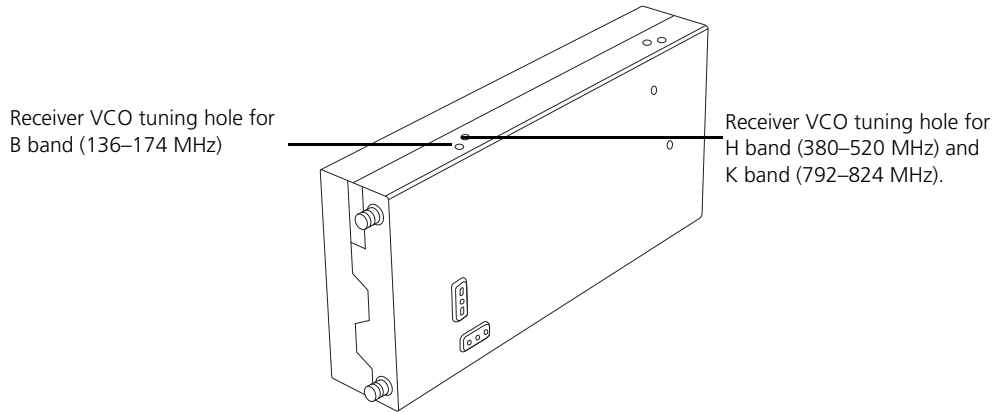
**Important:** Be careful when using the tuning tool. Applying too much pressure or attempting to turn the tool beyond the end of the range can crack the tuning slug. Unscrewing a slug too far can remove it completely.

## Adjusting the Receiver Lock Band

The first step in preparing the TB9100 base station for operation is to adjust the receiver lock band (switching range). The lock band is the range of frequencies that the receiver is calibrated to operate on.

### To adjust the receiver lock band

1. Set up the equipment and connect the Calibration Software to the reciter.
2. Select the Frequency Setup tab, and double-click **Set Receiver VCO**. The Set Receiver VCO Wizard appears. The display varies, depending on the reciter band.
3. Enter the Center Frequency (which must be a multiple of 500 kHz) of the lock band that you want to use, and click **Next**.
4. Insert the Murata tuning tool into the correct receiver VCO tuning hole for the reciter type (see below) and then click **Next**.
5. Adjust the receiver VCO trimmer until the actual band matches the desired band. The bands turn green. Click **Finish**. This stores the lock band in the reciter. The icon  on the Frequency Setup tab indicates that this task is complete. Proceed to tune the front end.



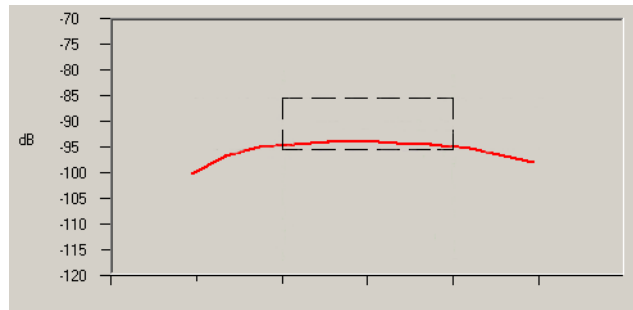
## Tuning a UHF Receiver Front End

The second step in tuning the receiver frequency is to tune the receiver front end, by adjusting the helical filters. Tuning aims to maximize the receiver's sensitivity and to optimize its response across the lock band (switching range).

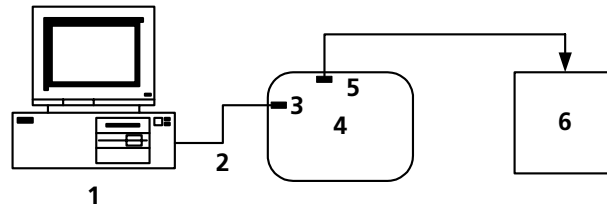
To help you do this, there is a graph of the RSSI readings in step two of the Tune Receiver Front End Wizard. A number of RSSI readings are measured across the switching range. These readings are then continually averaged to produce the graph.

**Important:** After tuning the receiver front end, you must re-calibrate the RSSI. This requires a signal generator. Otherwise the value reported by the CSS will be in error, RSSI gating levels will be incorrect in analog mode, and voting will be inaccurate in both modes.

You should aim to achieve a response that looks something like this:



## Setup



- 1 PC    2 RS-232 cable    3 Programming port  
4 CTU    5 Noise source    6 Reciter

### To tune the front end of a UHF (H-band) receiver, follow these steps.

1. Make sure that the equipment is correctly set up and that the Calibration Software is connected to the reciter.
2. Select the Frequency Setup tab, and double-click **Tune Receiver Front End**. The Tune Receiver Front End Wizard appears.

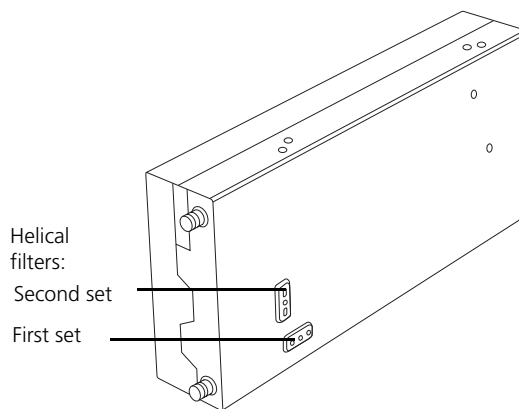


**Note:** If you haven't adjusted the receiver lock band in the current session, an alert appears, recommending that you run the Set Receiver VCO wizard first. If the lock band needs adjusting, click **Yes** and carry out that procedure first. If you are confident that the lock band is correct, click **No**.

3. Connect the CTU's noise source to the receiver input, turn the noise source on, and then click **Next**.
4. Click **Coarse (fast)** and use the tuning tool to roughly adjust the front-end helical filters on the receiver. As you do so, observe the graphical RSSI readings across the lock band. Adjust to maximize the response across the entire switching band.



**Note:** For final fine tuning, you may find it helpful to select a more sensitive scale, so that you can see the graphical reading in more detail.






Use the tuning tools as follows.

- a. Insert the Johanson tuning tool into the first hole of the first (horizontal) set. You can start with the hole on the left side and proceed along to the hole on the right, or vice versa. On K-band reciters, the third hole tends to tune with the slug well out of the filter body. Be careful not to unscrew the slug completely.
  - b. Tune each of the resonators in the first set once to give the best response.
  - c. Insert the Johanson tuning tool into the first hole of the second (vertical) set. You can start with the top hole and proceed down to the bottom hole, or vice versa. (For version 4.00 or earlier H-band reciters, use the Murata tuning tool on this set instead, as instructed by the wizard.)
  - d. Tune each of the resonators in the second set once to give the best response.
  - e. Repeat this procedure as necessary to refine the response.
5. Once you have roughly tuned the front-end helical filters, click **Fine (slow)**. Repeat the above procedure to fine tune the front-end helical filters until the response is peaked in the middle of the lock band and not more than -1 dB at the ends of the band.



**Note:** When using the Fine (slow) setting, you may notice a slight delay as the reading from tuning the front-end helical filters takes approximately one second to appear on the graph.

6. Click **Finish**. An alert appears, asking that you calibrate the RSSI. The icon  on the Frequency Setup tab indicates that this task is complete.
7. Re-calibrate the RSSI (see [“Calibrating the RSSI”](#) on page 18).

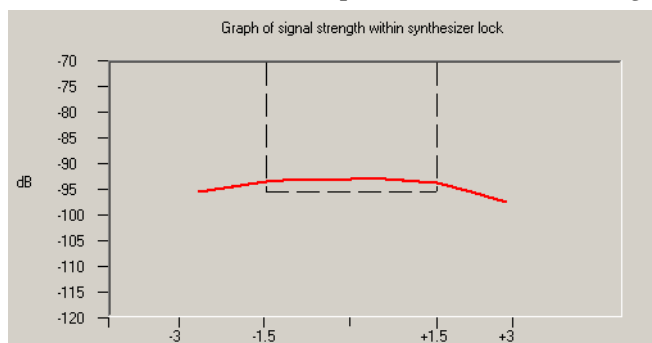
## Tuning a VHF Receiver Front End

The second step in tuning a VHF reciter is to tune the receiver front end, by adjusting trimmer capacitors. Tuning aims to maximize the receiver’s sensitivity and to optimize its response across the lock band (switching range).

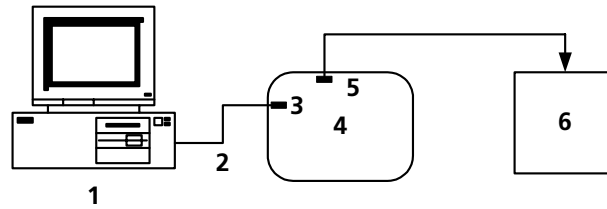
To help you do this, there is a graph of the RSSI readings in step two of the Tune Receiver Front End Wizard. A number of RSSI readings are measured across the switching range. These readings are then continually averaged to produce the graph.

**Important:** After tuning the reciter front end, you must re-calibrate the RSSI. This requires a signal generator. Otherwise the value reported by the CSS will be in error, RSSI gating levels will be incorrect in analog mode, and voting will be inaccurate in both modes.

You should aim to achieve a response that looks something like this:



## Setup



- 1 PC    2 RS-232 cable    3 Programming port  
4 CTU    5 Noise source    6 Reciter

### To tune a VHF (B-band) receiver front end, follow these steps.

1. Make sure that the equipment is correctly set up and that the Calibration Software is connected to the reciter.
2. Select the Frequency Setup tab, and double-click **Tune Receiver Front End**. The Tune Receiver Front End Wizard appears.



**Note:** If you haven't adjusted the receiver lock band in the current session, an alert appears, recommending that you run the Set Receiver VCO wizard first. If the lock band needs adjusting, click **Yes** and carry out that procedure first. If you are confident that the lock band is correct, click **No**.

3. Connect the CTU's noise source to the receiver input, turn the noise source on, and then click **Next**.
4. Click **Coarse (fast)** and use the Murata tuning tool to roughly adjust the four front-end trimmers on the receiver (see below). You can do this in any order. As you do so, observe the graphical RSSI readings across the lock band. Adjust to optimize the response across the entire switching band.




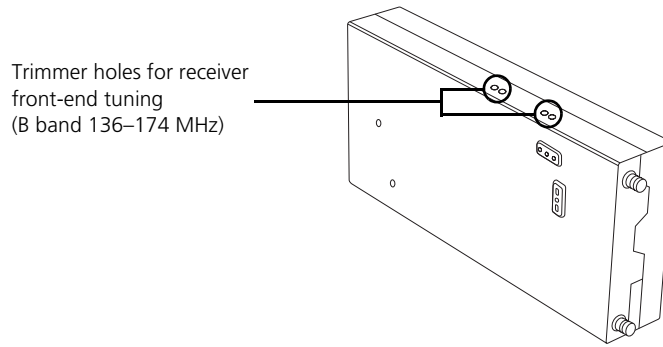
**Note:** For final fine tuning, you may find it helpful to select a more sensitive scale, so that you can see the graphical reading in more detail.

5. Once you have roughly tuned the trimmers, click **Fine (slow)**. Repeat the above procedure until the response is flat in the middle of the lock band and not more than -1 dB at the ends of the band.



**Note:** When using the Fine (slow) setting, you may notice a slight delay as the reading from tuning the trimmers takes approximately one second to appear on the graph.

6. Click **Finish**. An alert appears, asking that you calibrate the RSSI. The icon  on the Frequency Setup tab indicates that this task is complete.
7. Re-calibrate the RSSI (see [“Calibrating the RSSI” on page 18](#)).



## Adjusting the Exciter Lock Band


If you are preparing the base station for operation, adjusting the exciter lock band is the third step in tuning the reciter. Alternatively, this procedure can be performed independently of the other two calibration wizards on the Frequency Setup tab. Adjusting the exciter lock band defines the range of frequencies that the base station is able to transmit on.

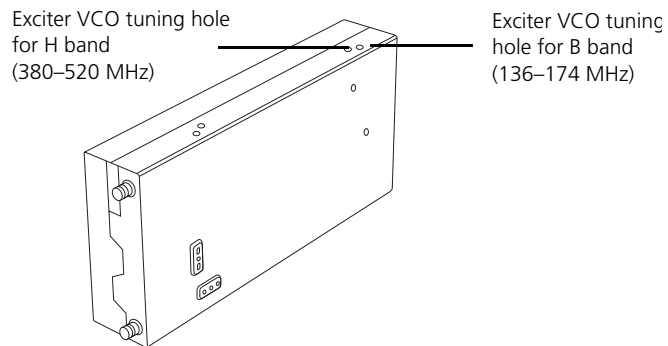


**Note:** When performing this procedure, you don't need to terminate the exciter output port. An internal output pad means that there is a good impedance match at this interface.

### To calibrate the exciter lock band

1. Set up the equipment and connect the Calibration Software to the reciter.
2. Select the Frequency Setup tab, and double-click **Set Exciter VCO**. The Set Exciter VCO Wizard appears.
3. Enter the center frequency (which must be a multiple of 500 kHz) of the lock band that you want to use, and click **Next**.
4. Insert the Murata tuning tool into the correct exciter VCO tuning hole (see below) and adjust the trimmer until the actual band matches the desired band. The bands turn green. Click **Finish**.

Once you have finished adjusting the exciter lock band, the icon  on the Frequency Setup tab indicates that this task is complete.



## Selecting the Exciter Sub-band

The lock band of K-band exciter does not normally need adjusting. Instead you select a sub-band. These exciter have two VCOs and the one you select determines the sub-band that is displayed on CSS monitoring screens and that has its lock range determined in diagnostic tests. However, exciter can always operate on frequencies in either sub-band.

### Equipment


- Murata tuning tool
- CTU

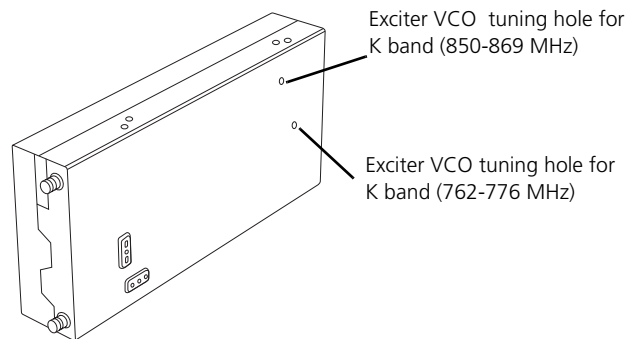
#### To select the exciter sub-band

1. Ensure you are already connected to the reciter (see [“Connecting to a Reciter Outside the Subrack”](#) on page 8).
2. Select the Frequency Setup tab, and double-click **Set/Select Exciter VCO**. The Set/Select Exciter VCO Wizard appears.
3. Select the check box to skip the tuning steps and then click **Next**.

Alternatively, if the reciter RF board has been repaired, you need to adjust the lock band. Select one of the two available lock bands and then click **Next**. Insert the Murata tuning tool into the correct exciter VCO tuning hole (see below) and adjust the trimmer until the actual band matches the desired band. The bands turn green. Click **Next**.

4. Select one of the two available lock bands. This specifies the lock band used for display and for diagnostic tests.
5. Click **Finish**.

If you adjusted the lock band, the icon  on the Frequency Setup tab indicates that this task is complete. If you simply selected the sub-band, the icon is unchanged, indicating that there was no adjustment.



# Calibrating the Reciter

---

The reciter is fully calibrated in the factory, but if the reciter is serviced you may need to perform the following procedures:

- [Calibrating the Exciter](#)
- [Calibrating the RSSI](#)
- [Calibrating the Balanced Line](#)

To compensate for frequency drift, you may need to perform the following:

- [Carrier Frequency Offset Adjustment](#)

All these procedures can be done independently of each other, although it is recommended that you tune the receiver *before* you calibrate the RSSI.



**Important:** It is recommended that only accredited service centers and Tait engineers perform these procedures.

## Calibrating the Exciter

You will need to calibrate the exciter if you have made component-level repairs to it. There are three steps:


1. [Auto-tune the FCL](#)
2. [Calibrate the FCL](#)
3. [Calibrate the VCO](#)

### Automatically Tune the Frequency Control Loop (FCL)

Tuning the FCL calibrates the voltage levels used in the detectors for the FCL.

#### To automatically tune the FCL

1. Set up the equipment and connect the Calibration Software to the reciter.
2. Select the Reciter Calibration tab, and double-click **FCL Auto Tuning**. The FCL Auto Tuning Wizard appears.
3. Click **Calibrate** to automatically tune the FCL.

The icon  on the Reciter Calibration tab indicates that this task is complete. You will now need to [calibrate the FCL](#).

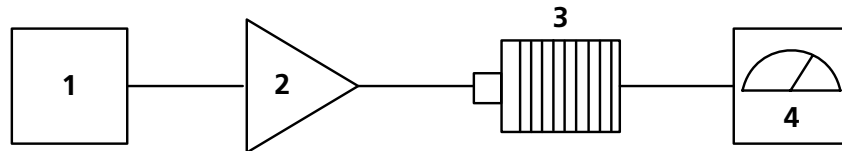
### Calibrating the FCL

This is step two of calibrating the exciter. Once you have auto-tuned the FCL, you should calibrate it.

#### Equipment

- Murata tuning tool
- Modulation meter
- RF attenuator (only required if you are using a PA)


## Setup



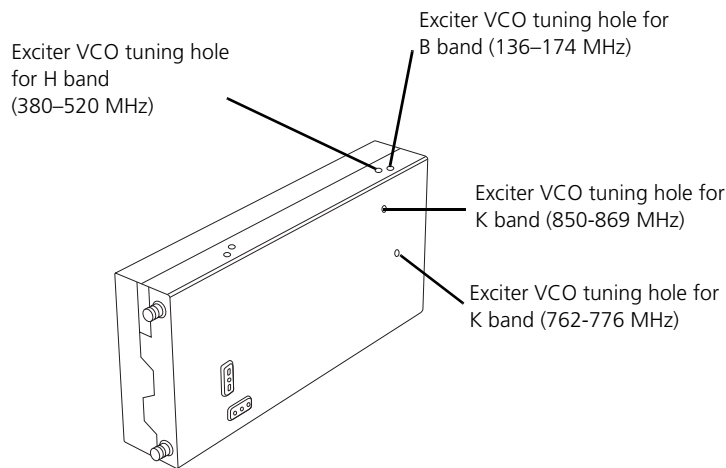
- |   |               |   |   |
|---|---------------|---|---|
| 1 | Reciter       | 3 | RF attenuator (only required if using a PA) |
| 2 | PA (optional) | 4 | Modulation meter                            |

### To calibrate the FCL

1. Make sure that the equipment is set up and that the Calibration Software is connected to the reciter.
2. Select the Reciter Calibration tab, and double-click **FCL Calibration**. The FCL Calibration Wizard appears.
3. In the drop-down list, select the model of the test set you will use for the calibration.
4. Set the modulation meter according to the instructions in the wizard, and then click **Next**. (If you are using a PA, it will now transmit.)
5. Insert the tuning tool into the correct exciter VCO tuning hold (see below) and adjust the trimmer until the actual band matches the desired band. The bands turn green. Click **Next**.
6. If the modulation meter cannot auto-tune, set its frequency to the displayed value. This is the mid-point of the actual band, as determined by step 2 of the wizard. Click **Next**.
7. Use the slider to adjust the deviation at 1 kHz until it is 2.11 kHz or 2107 Hz RMS (3 kHz peak).
8. Select the 30 Hz Modulation Test and adjust the deviation at 30 Hz until it is 2.11 kHz or 2107 Hz RMS (3 kHz peak).
9. Repeat steps 7 and 8 until the deviation is 2.11 kHz or 2107 Hz RMS at both 1 kHz and 30 Hz. Aim for an accuracy of +/- 10 Hz.
10. Click **Finish**. (If you are using a PA, it will now stop transmitting.)

When you have finished calibrating the FCL, the icon  on the Reciter Calibration tab indicates that this task is complete.

You will now need to [calibrate the VCO](#).



## Calibrating the VCO

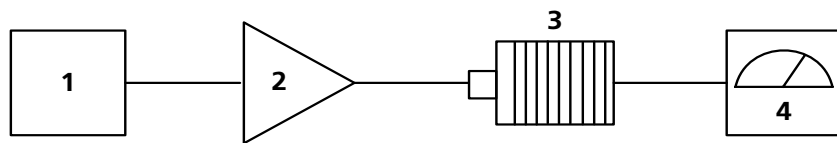
This is step three of calibrating the exciter.

Once you have tuned and calibrated the FCL, you calibrate the VCO at frequencies across the whole lock band. This involves selecting a sub-band, adjusting the lock band trimmer, and then moving on-screen sliders to adjust the deviation to 3 kHz for each of a set of frequencies.

### Equipment

- Murata tuning tool
- Modulation meter
- RF attenuator (only required if you are using a PA)

### Setup




- |                 |   |
|-----------------|---|
| 1 Reciter       | 3 RF attenuator (only required if using a PA) |
| 2 PA (optional) | 4 Modulation meter                            |

### To calibrate the VCO

1. Make sure that the equipment is set up and that the Calibration Software is connected to the reciter.
2. Select the Reciter Calibration tab, and double-click **VCO Calibration**. The VCO Calibration Wizard appears.
3. In the drop-down list, select the test set model you will use for the calibration.
4. Set the modulation meter according to the instructions in the wizard, and then click **Next**. (If you are using a PA, it will now transmit.)
5. Adjust the exciter lock band trimmer until the actual band matches the desired band. The bands turn green.
6. Click **Next**. Step 3 of the wizard appears.

7. Calibrate each of the frequencies shown. Follow these steps.
  - a. Click the option button alongside a frequency.
  - b. If the modulation meter cannot auto-tune, set its frequency to the selected value.
  - c. Using the Fine and Coarse arrows, adjust the slider until the deviation shown on the modulation meter is 3000 Hz (peak).
  - d. Repeat steps a) and b) until all frequencies for the band are calibrated. This enables the **Next Band** button.
8. Click **Next Band** and repeat steps 4) through 6). Repeat until all frequencies in all bands have been calibrated.
9. If you are connected to a K-band reciter, click **Next**. Select one of the two sub-bands. This determines the sub-band that is displayed on CSS monitoring screens and that has its lock range determined in diagnostic tests. However, exciters can always operate on frequencies in either sub-band.
10. Click **Finish**. (If you are using a PA, it will now stop transmitting.)

When you have finished calibrating the VCO, the icon  on the Reciter Calibration tab indicates that this task is complete.

You should now [adjust the exciter lock band](#) because it was re-tuned several times during this procedure. This means that the exciter is no longer on the required frequency. If you have P25 test equipment, we also recommend that you carry out a modulation fidelity test to verify the adequacy of the FCL and VCO calibration for digital P25 transmissions.

## Calibrating the RSSI

Calibrating the RSSI (received signal strength indicator) ensures that the reciter's internal RSSI values accurately reflect the actual received signal strength. Changing the receiver's lock band can alter the calibration accuracy by about 1 dB.

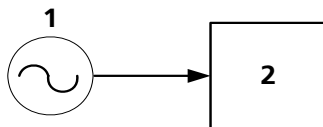


**Note:** Ensure that the receiver's lock band has already been adjusted to the required setting before carrying out this procedure. (See [“Adjusting the Receiver Lock Band”](#) on page 8.)

### Equipment

- RF signal source

### Setup




- 1 RF signal source
- 2 Reciter

### To calibrate the RSSI

1. Make sure that the equipment is set up and that the Calibration Software is connected to the reciter.



2. Select the Reciter Calibration tab, and double-click **RSSI Calibration**. An alert appears, recommending that you tune the receiver. If the receiver needs tuning, click **Yes** and carry out that procedure before continuing. If you are confident that the receiver is correctly tuned, click **No**. The RSSI Calibration Wizard appears.
3. Apply a signal (modulated at 1 kHz tone, 3kHz deviation peak) at the base station's center frequency. Use the CTU to confirm that the tone is being output on the line, and then click **Next**.
4. Set the RF input signal to a level of -80 dBm, and then click **Next**.
5. Vary the RF level, and check that the value shown in the RSSI Gain Setting box corresponds with the value shown on your test instrument. This is to make sure the RSSI is correctly calibrated. Click **Finish**.

When you have finished calibrating the RSSI, the icon  on the Reciter Calibration tab indicates that this task is complete.

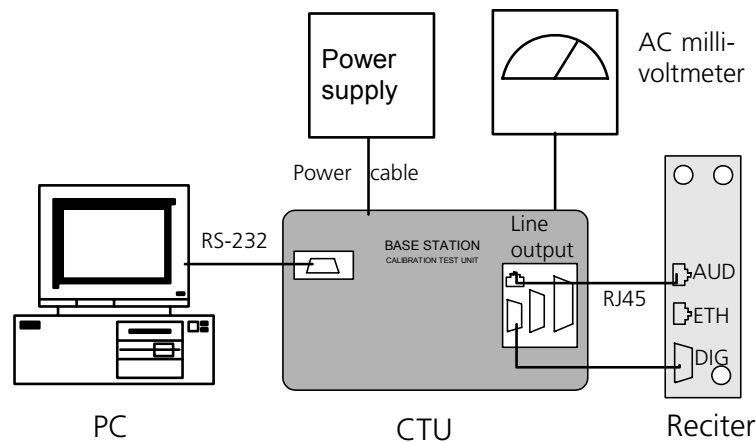
## Calibrating the Balanced Line

This procedure is carried out on the analog line if the reciter network board has been replaced or repaired. It adjusts the gain, so that when you set line levels using the CSS, the actual line level correctly reflects the CSS settings. (Refer to the *TB9100 Customer Service Software User's Manual* for further information.)

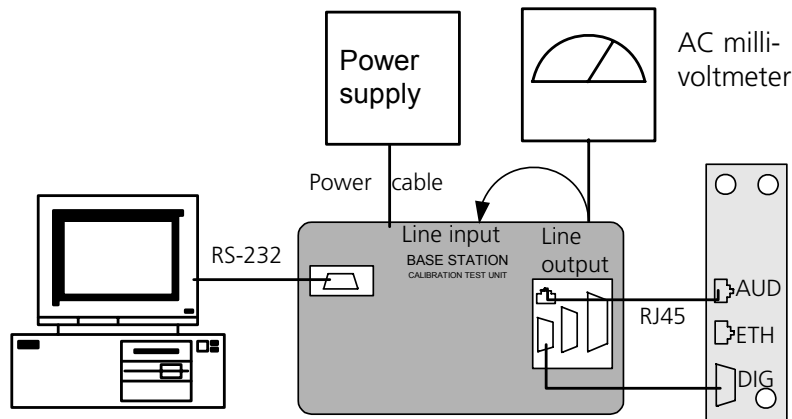
### Equipment

- CTU
- AC millivoltmeter

### Setup for Line Out



### Setup for Line In




### To calibrate the analog input and output lines

1. Make sure that the equipment is set up and that the Calibration Software is connected to the reciter.
2. Select the Reciter Calibration tab, and double-click **Balanced Line Calibration**. The Balanced Line Calibration Wizard appears.
3. Attach an AC millivoltmeter and terminate the output in 600 ohms (*either* using the load on the CTU *or* looping the balanced output to the balanced input), and then click **Next**.
4. Adjust the slider in the dialog box until the audio level on the millivoltmeter reads 1 VPP (0.354 VRMS).



**Note:** Click **Coarse** to roughly adjust the audio level, and once you get within range, click **Fine** for more precise control over the settings. To move up or down 10 mVPP, click either side of the slider bar.

5. Click **Next**. The balanced output is now calibrated.
6. Note the level of the AC millivoltmeter, and then turn off the 600 ohm load.
7. Connect the analog output to the analog input. Verify that the millivoltmeter reading is substantially unchanged. (This confirms that the input provides a 600 ohm impedance.)
8. Click **Finish**. The balanced input is now calibrated.

When you have finished calibrating the analog line, the icon  on the Reciter Calibration tab indicates that this task is complete.

## Calibrating the Unbalanced Lines

This procedure is not carried out on the TB9100. The TB9100 does not have an unbalanced line.

## Carrier Frequency Offset Adjustment

The TCXO (temperature compensated crystal oscillator) provides a reference frequency from which all other RF frequencies are derived. TB9100 reciters have a voltage-controlled TCXO with a pot for adjusting the reference frequency to remove any carrier frequency offset. The Carrier Freq Offset Adjustment wizard provides assistance with this procedure.

This procedure is not normally needed in the field for VHF base stations. For UHF and above, Tait recommends that the reciter TCXO is checked after 3 months service and adjusted if the error is  $> 0.5$  ppm.

Annual checks should be made thereafter to detect any frequency drift. The reciter TCXO should only be adjusted if the actual transmit frequency has drifted more than 0.5 ppm from the configured value.

Tait recommends that the TCXO is calibrated to within 0.1 ppm.

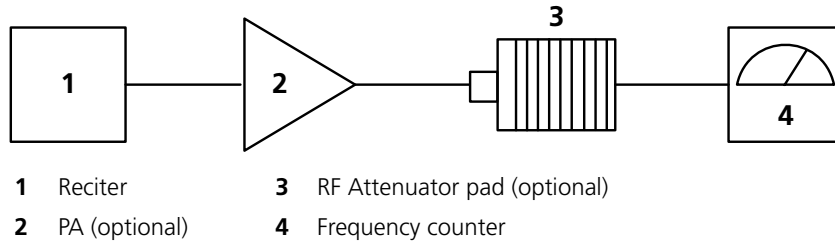
## Equipment

- Torx 10 screwdriver (to remove the reciter cover)
- Tuning tool
- Frequency counter with an accuracy of 50 parts per billion or better. The equipment must either have its own internal high-accuracy reference or be locked to an external reference such as the Tait T805.
- RF attenuator (only required if you are using a PA)



**Important:** The accuracy of the calibrated TCXO frequency is only as good as the accuracy of the frequency counter.

## Setup



You need direct access to the TCXO circuitry on the reciter RF board. This involves removing the reciter RF cover.



**Important:** The reciter contains devices that are susceptible to damage from static charges. You must handle these devices according to the recommended ESD precautions.

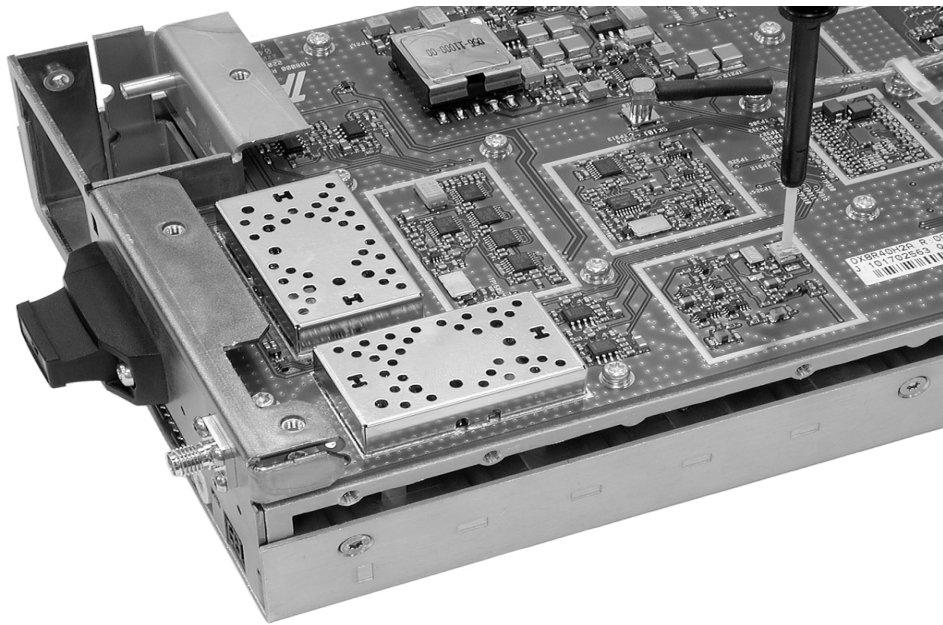
### To adjust the carrier frequency

1. Remove the reciter from the subrack.
2. Remove the M3 Torx screws securing the reciter RF cover to the heatsink and to the front and rear panels. (The RF side of the reciter can be identified by the two BNC connectors on that side of the reciter's rear.) Lift off the RF cover.
3. Make sure that the equipment is set up and that the Calibration Software is connected to the reciter.
4. Select the Reciter Calibration tab, and double-click **Carrier Freq Offset Adjustment**. The Carrier Freq Offset Adjustment wizard appears.
5. Attach an appropriate load and frequency counter (or a test set) to the exciter or PA output, and then click **Next**.

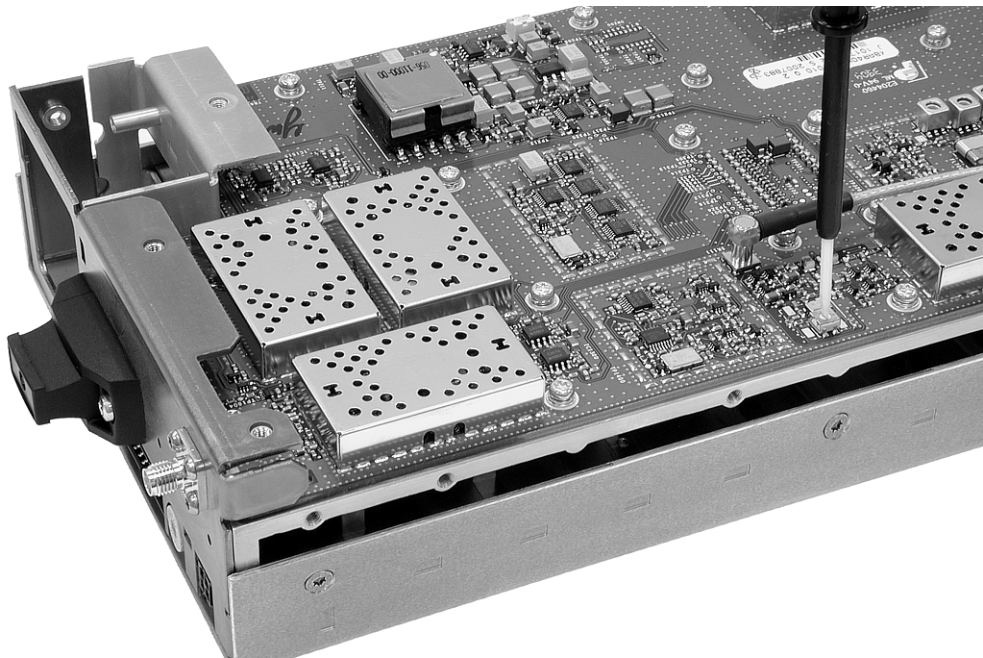
The exciter now begins transmitting on the center frequency of its lock band. The Wizard displays a message similar to the following:  
“Adjust RV1400 to set frequency within 0.1 ppm or 48Hz of 485 MHz”


6. Use the tuning tool to adjust the TCXO tuning control (RV1400) so that the reciter is transmitting exactly on frequency.

The following shows where the tuning control is located on B-band and H-band reciters:



The following shows where the tuning control is located on K-band reciters:



7. Click **Finish**. Transmission ceases and the icon  on the Reciter Calibration tab indicates that this task is complete.
8. Replace the reciter RF cover, as follows.
  - a. Slide the cover into place over the front and rear panels. Make sure the holes in the cover line up with the threaded holes in the heatsink and front and rear panels.
  - b. Press the cover firmly into place and screw in the M3 Torx screws, first on the flat face, then on the edge face.



**Important:** Excessively tightening the screws can damage the thread of the aluminium heatsink. Tait recommends that you use a T10 torque driver set to 0.5 Newton meters (4.5 lbf.in).



# Calibrating the Power Amplifier

---

The PA is fully calibrated in the factory, but if the PA is serviced you may need to perform the following procedures:

- [Calibrating the PA Bias](#)
- [Calibrating the Forward and Reverse Detector Bias Voltages](#)
- [Calibrating the PA Power](#)

Perform the procedures in the above order.



**Important:** It is recommended that only accredited service centers and Tait engineers perform these procedures.

## Calibrating the PA Bias

The driver and final transistors of the power amplifier must be biased at a constant current. Since the characteristics of individual transistors vary slightly, the bias current is calibrated for each device.

If either the driver or final transistor, or the PCB modules themselves, are replaced during servicing, you should perform this procedure to calibrate the bias current for the new device.

The bias current required for each amplifier stage is stored within the PA. During the calibration process, the microprocessor adjusts the gate bias voltage to obtain the required bias current for each stage.


The stage bias calibration sets up the amplifier's DC operating conditions. These DC conditions will be upset if there is RF present during calibration. It is important to disconnect the RF cable from the PA input to avoid this.

The other conditions which must be met to ensure a successful calibration are as follows:

- No other Calibration Wizards are running
- The supply voltage is within the range 27–29 V (for 12 V PAs, assume that the internal voltage is within this range)
- The temperature of each stage is within the range 5–50°C

### To calibrate the PA stage bias current

1. Make sure that the equipment is set up and that the Calibration Software is connected to the reciter.
2. Select the PA Calibration tab, and double-click **Calibrate PA Bias**.
3. Ensure that the exciter RF is isolated from the PA by disconnecting the SMA connector on the PA front panel.
4. Click **Calibrate** to calibrate the PA bias.

When you have finished calibrating the power amplifier bias, the icon  on the PA Calibration tab indicates that this task is complete.

## Calibrating the Forward and Reverse Detector Bias Voltages


The RF detectors, used for measuring the forward and reverse power, operate with a small bias current. The resulting bias voltage from each detector (with no RF present) is read and stored inside the PA. These voltages are used when calculating the Antenna VSWR (Voltage Standing Wave Ratio).

You should calibrate the forward and reverse detector bias voltages:

- If the Low Pass Filter (LPF)/directional coupler PCB module is replaced
- After servicing of any components in the detector circuitry (such as the detector diodes) on the LPF/ directional coupler PCB

### To calibrate the forward and reverse detector bias voltages

1. Make sure that the equipment is set up and that the Calibration Software is connected to the reciter.
2. Select the PA Calibration tab, and double-click **Calibrate Fwd/Rev Detector Bias Voltages**.
3. Ensure that the PA is not transmitting and that there is no RF source present at the PA RF input or output by disconnecting the input SMA connector on the PA front panel and the 'N' type output connector from the rear of the PA. Click **Calibrate**.

When you have finished, the icon  on the PA Calibration tab indicates that this task is complete.

## Calibrating the PA Power

The power amplifier (PA) receives the RF signal from the reciter and amplifies it to the required level, in watts, as requested by the reciter. The desired output power is determined by the reference voltage for the power control loop.

The PA power control loop is calibrated at a single frequency, generally in the center of the operating band.

You perform the calibration procedure to define – for each power level – the reference DAC (Digital-to-Analog Converter) value and forward detector voltage.

You should only need to re-calibrate the PA power if:

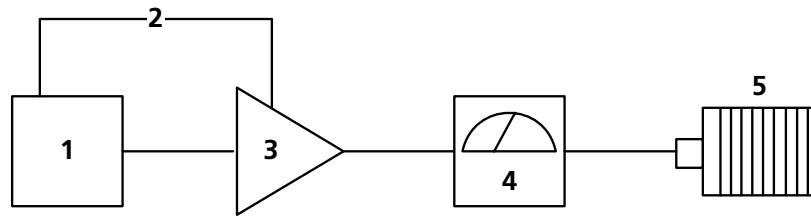
- The Low Pass Filter (LPF)/directional coupler PCB module is replaced
- Any repairs are carried out on the forward and reverse detector circuitry on the Low Pass Filter/directional coupler PCB module
- You require a more accurate power calibration on a specific frequency

### Equipment

- *Either* an inline power meter and 50 ohm load with a high power rating, *or*
- A terminating power meter and appropriate 50 ohm attenuator with a high power rating



## Setup for Inline Power Meter



- |                |                  |        |
|----------------|------------------|--------|
| 1 Reciter      | 3 PA             | 5 Load |
| 2 16-way cable | 4 RF Power Meter |        |



**Note:** Cables and connectors can easily cause a power loss of several watts if either too long or poorly terminated. Always use the shortest possible leads (or connectors instead of leads) between the PA and power meter set-up.

### To calibrate the PA transmit power

1. Make sure that the equipment is set up and that the Calibration Software is connected to the reciter.
2. Select the PA Calibration tab, and select **Calibrate PA Power**.
3. Ensure that the power meter and a 50 ohm load (VSWR < 1.2:1) with a high power rating are connected to the power amplifier RF output, and then click **Next**.
4. Check that the PA RF input is connected to the reciter RF output, and that the PA and the reciter are connected by a control bus, and then click **Next**.
5. For each power level shown, use the slider to adjust the DAC setting to get the required power output, and then click **Next Power** to move to the next line.




**Note:** Click **Coarse** to roughly adjust the DAC setting, and once you get within range, click **Fine** for more precise control over the settings. To move up or down one DAC value, click either side of the slider bar.



**Note:** You must perform the calibration in sequence from the lowest to the highest step. The DAC setting must be greater than the previous one otherwise the value will not be stored in the PA, and you cannot move to the next line.

6. When you have completed adjusting the DAC settings, click **Finish**.

When you have finished, the icon  on the PA Calibration tab indicates that this task is complete.

## Troubleshooting Tips

### **DAC Settings**

When you adjust the DAC settings, the values for the DAC Setting, Coupler Fwd Voltage, and Control Voltage should always increase as the power level increases. If these values do not increase, there is either a fault with the PA or the previous step was not calibrated correctly. If you make a mistake in the calibration table, you must start again from step 1.

### **Control Voltage**

The Control Voltage is shown in the table to indicate the operation point within the power control loop. The range of the control voltage is from 0 V to 7.5 V. If the control voltage reaches its limit before achieving maximum power in the table, this indicates either a faulty gain stage in the PA or low RF input power to the PA.

### **VSWR**

The VSWR (Voltage Standing Wave Ratio) is monitored at the RF output of the PA during calibration. The software will not allow calibration into a load VSWR > 1.3:1. If a calibration step cannot be stored, check that the load VSWR is <1.3:1. It is recommended that the load should have an input VSWR <1.2:1.

# Calibrating the Power Management Unit

---

There is only one calibration procedure for the PMU: calibrating its output voltage.

## Calibrating the PMU Output Voltage

Calibrating the PMU output voltage adjusts the voltage to be 28.00 V. This procedure is only carried out when a replacement control card or microprocessor is fitted to the PMU. Normally, the output voltage will be accurate without calibration.



**Note:** Re-calibrating the PMU output voltage may in fact result in it failing to meet the published specification of  $\pm 0.5\%$  accuracy. This is because control cards are calibrated in the factory under half-load, giving a voltage that is closer to 28.00 V under varying loads.

### To calibrate the output voltage

1. Make sure that the equipment is set up and that the Calibration Software is connected to the reciter.
2. Select the **PMU Calibration** tab.
3. Double-click **Output Voltage Calibration**. The Calibrate Output Voltage wizard appears.
4. Connect a digital multimeter to the PMU output and read the output voltage.
5. Enter the voltage into the **PMU Voltage** box and click **Calibrate**.
6. When the wizard indicates that the calibration completed successfully, click **Finish**.



# Index

---

## A

- AC millivoltmeter 3
- analog line, calibrating 20
- audio level
  - calibrating 20

## B

- Balanced Line Calibration Wizard 20
- band 1
  - entering 4
- base station
  - disconnecting from 7
  - receive only 5

## C

- Calibrate Fwd/Rev Detector Bias Voltages Wizard 26
- Calibrate Output Voltage wizard 29
- Calibrate PA Bias Wizard 25
- Calibrate PA Power Wizard 27
- Calibration and Test Unit 3
  - connecting up 6
- calibration wizards 1
  - FCL Auto Tuning Wizard 15
  - RSSI Calibration Wizard 19
  - Set Exciter VCO Wizard 13, 14
  - Tune Receiver Front End Wizard 10, 12
- Carrier Freq Offset Adjustment Wizard 22
- carrier frequency, calibrating 21
- COM port, selecting 5
- control voltage 28
- coupler fwd voltage 28
- CTU
  - connecting up 6

## E

- equipment 3
  - tuning tool 14
- exciter
  - adjusting lock band 13
  - calibrating 15, 15
  - component repairs to 15

## F

- FCL (Frequency Control Loop)

- calibrating 15

- FCL Calibration Wizard 16
- frequency
  - defining range of 13

## G

- gate bias voltage, adjusting 25

## H

- hardware version
  - entering 4

## J

- Johanson 8777 tuning tool 3

## L

- lock band
  - adjusting on exciter 13
  - adjusting on receiver 8
- log files
  - application errors 7
  - commands received and sent 7

## M

- module number 1
- Murata tuning tool 3

## P

- P25 Console Gateway 5
- PA
  - calibrating bias current 25
  - calibrating transmit power 26
  - faulty gain stage 28
  - low RF input power 28
  - viewing details of 1
- PMU
  - calibrating output voltage 29
- power supply 3
- product code
  - entering 4

## R

- receive-only base station 5
- receiver

- adjusting lock band [8](#)
- tuning front end helical filters [9, 11](#)
- reciter
  - calibrating [15](#)
  - connecting to (outside subrack) [6](#)
  - tuning the frequency [8](#)
  - viewing details of [1](#)
- Reference DAC [26](#)
- resonators
  - see front end helical filters
- RF attenuator
  - see equipment
- RF detectors
  - calibrating bias voltage of [26](#)
- RSSI (Received Signal Strength Indicator)
  - tuning receiver [9, 11](#)

## S

- serial number [1](#)
  - entering [4](#)
- Set Receiver VCO Wizard [8](#)
- status bar [2](#)
- switching range
  - adjusting [8](#)

- definition [8](#)

## T

- TCXO (Temperature Compensated Crystal Oscillator)
  - calibrating [21](#)
- tool kit [3](#)
- toolbar [2](#)
- troubleshooting [7](#)
  - PA power calibration [28](#)
- tuning tool [3](#)

## V

- VCO Calibration Wizard [17](#)
- version
  - of Calibration Software [7](#)
- VSWR
  - calibrating bias voltages used to calculate [26](#)
  - may prevent calibration [28](#)

## W

- wizards [1](#)

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